

OPTICAL POWER MONITORING FOR A SEMICONDUCTOR LASER DEVICE

Cross-Reference to Related Applications

This application claims the benefit of U.S. Provisional Application Number 60/446,126, filed 10 February 2003.

Field of the Invention

This invention relates to optoelectronic packages and, more particularly, to monitoring the optical output power of a semiconductor laser device typically used in such packages.

Background of the Invention

20 Optoelectronic packaging solutions for light emitting
21 devices are designed to allow efficient coupling of the light
22 emitting device with an optical system. The light emitting
23 device is driven by control circuitry which may or may not be
24 housed in the optoelectronic package with the light emitting
25 device. However, a compact package with a high optical

1 coupling efficiency is still desirable. The package must also
2 provide adequate thermal dissipation of the heat generated by
3 the light emitting device and associated circuitry.

4

5 In addition, it is also desirable to monitor the optical
6 power of the light emitting device, generally to ensure a
7 constant output from individual devices and to ensure a
8 standard output between similar devices. Optical power
9 monitoring is often done by placing a photodetector device
10 proximate to the light emitting device. However, the placement
11 of the photodetector device introduces numerous design
12 constraints to the overall optoelectronic package. For
13 example, it is desirable to make the optoelectronic package as
14 compact as possible. It is also desirable to provide accurate
15 optical power monitoring which is not substantially susceptible
16 to alignment variations between the light emitting device and
17 the photodetector. Critical alignment or placement
18 requirements can substantially increase the labor, time, and
19 cost of manufacturing the optoelectronic packages.

20

21 It would be highly advantageous, therefore, to remedy the
22 foregoing and other deficiencies inherent in the prior art.

23

24 An object of the present invention is to provide a new and
25 improved power monitoring arrangement for semiconductor laser
26 devices used in optoelectronic packages.

1 Another object of the present invention is to provide a
2 new and improved power monitoring arrangement for semiconductor
3 laser devices that can be easily be incorporated into any of
4 the present optoelectronic packages.

5

6 Another object of the present invention is to provide a
7 new and improved power monitoring arrangement for semiconductor
8 laser devices that greatly simplifies manufacturing of
9 optoelectronic packages.

1 Summary of the Invention

2

3 Briefly, to achieve the desired objects of the instant
4 invention in accordance with a preferred embodiment thereof, a
5 power monitoring arrangement for semiconductor light emitting
6 devices used in optoelectronic packages is disclosed. The
7 arrangement includes a mounting structure having a mounting
8 surface, a light emitting device providing emitted light at a
9 monitoring output and an active output positioned on the
10 mounting surface of the mounting structure, and a monitor
11 photodetector, having a light sensitive region, positioned on
12 the mounting surface of the mounting structure proximate the
13 monitoring output of the light emitting device. A hemisphere
14 of material is formed to include at least the light sensitive
15 region of the monitor photodetector and the monitoring output
16 of the light emitting device. An outer surface of the
17 hemisphere operates as a reflector to reflect light from the
18 monitoring output of the light emitting device to the light
19 sensitive region of the monitor photodetector. Because of the
20 wide band of light reflected by the inner surface of the
21 hemisphere positioning of the monitor photodetector is
22 completely non-critical and, basically, only needs to be within
23 the hemisphere.

24

25 The desired objects of the instant invention are further
26 realized in a method of mounting power monitoring apparatus for

1 semiconductor light emitting devices in optoelectronic
2 packages. The method includes the steps of providing a
3 mounting structure having a mounting surface, positioning a
4 light emitting device with an emitted light output and a
5 monitoring output on the mounting surface of the mounting
6 structure, and positioning a monitor photodetector having a
7 light sensitive region on the mounting surface of the mounting
8 structure proximate the monitoring output of the light emitting
9 device. The method further includes the step of forming a
10 hemisphere of material on the mounting surface so as to include
11 at least the light sensitive region of the monitor
12 photodetector and the monitoring output of the light emitting
13 device. An outer surface of the hemisphere operates as a
14 reflector to reflect light from the monitoring output of the
15 light emitting device to the light sensitive region of the
16 monitor photodetector.

1 Brief Description of the Drawings

2

3 The foregoing and further and more specific objects and
4 advantages of the instant invention will become readily
5 apparent to those skilled in the art from the following
6 detailed description of a preferred embodiment thereof taken in
7 conjunction with the drawings, in which:

8

9 FIG. 1 is a semi-schematic side view of an optoelectronic
10 package in accordance with the present invention;

11

12 FIG. 2 is a semi-schematic top view of the optoelectronic
13 package of FIG. 1; and

14

15 FIG. 3 is a semi-schematic top view of a modification of
16 the optoelectronic package of FIG. 1.

Detailed Description of the Drawings

3 Turning now to FIG. 1, an optoelectronic package 5 in
4 accordance with the present invention is illustrated. In this
5 embodiment, optoelectronic package 5 includes a supporting
6 structure 11. Supporting structure 11 can be, for example, a
7 semiconductor substrate, a ceramic substrate, a heatsink, or
8 another supporting material with and/or including a desired
9 thermal conductivity. Further, supporting structure 11 can be
10 virtually any desired shape and may be, in some applications, a
11 part of a larger structure, e.g. a ceramic or printed circuit
12 board.

14 In this embodiment, a light emitting device 10 is
15 positioned on a surface of supporting structure 11. Device 10
16 can be fixedly attached to supporting structure 11 using
17 adhesive, a solder, or the like. Light emitting device 10 can
18 be, for example, a semiconductor laser device or a similar
19 light emission device wherein it is desirable to monitor the
20 optical power output. In this specific example, light emitting
21 device 10 is an edge emitting semiconductor laser that includes
22 an active region 12 which emits light, represented by cone 13
23 in one direction and light represented by cone 14 in the
24 opposite direction.

1 It will be understood by those skilled in the art that
2 most semiconductor light emitting devices emit light in a
3 generally conical shaped beam with different breadths for
4 different types of devices. Also, in this specific example,
5 cone 14 represents the light that is usually coupled into an
6 optoelectronic system and is the light that is of most interest
7 to be monitored. Further, light represented by cone 13 and
8 light represented by cone 14 include similar light that is
9 directly associated so that changes in the power of light
10 represented by cone 14 appear as similar changes to the light
11 represented by cone 13.

12

13 In this embodiment, a photodetector 16 is positioned on
14 the surface of supporting structure 11 and proximate to light
15 emitting device 10. Photodetector 16 can be fixedly attached
16 to structure 11 using adhesive, a solder, or the like.
17 Photodetector 16 includes a light sensitive region 18 which is
18 substantially sensitive to the wavelength of light represented
19 by cone 13. Photodetector 16 can be, for example, a PIN
20 photodetector, an avalanche photodetector, or any similar
21 photosensitive device that is capable of detecting light
22 emitted from light emitting device 10.

23

24 A hemisphere of an adhesive material 19 is positioned to
25 partially enclose light emitting device 10 and all or
26 substantially all of photodetector 16. Adhesive material 19

1 can be, for example, silicone and silicon compounds, various
2 epoxies and plastics, liquid glass, or another material with a
3 desired property for adhesion and also a desired property for
4 conducting light represented by cone 13. Preferably, adhesive
5 material 19 is provided in a liquid or semi-liquid state so
6 that a drop of the material can be placed on light emitting
7 device 10 and photodetector 16, as illustrated, and natural
8 adhesion to the surface forms the hemisphere normally or
9 automatically. Further, the difference in indices of
10 refraction between material 19 and the surrounding air, gas, or
11 vacuum (if the package is to be hermetically sealed) produces a
12 mirror effect at the surface that reflects light from light
13 emitting device 10 back into the hemisphere as illustrated by
14 arrow 17.

15

16 Since light from light emitting device 10 is emitted in a
17 shape generally represented by cone 13, the reflected light
18 (arrow 17) will cover a relatively broad area and the position
19 of photodetector 16 is completely non-critical. As illustrated
20 in FIG. 2 photodetector 16 can be positioned virtually
21 anywhere, within hemisphere of material 19 along a line
22 representing the longitudinal axis of light emitting device 10.
23 Further, as illustrated in FIG. 3, because of the hemispherical
24 shape of material 19, photodetector 16 can be positioned to
25 either side of the path of direct travel of light from light
26 emitting device 10. As illustrated in FIG. 3, light emitting

1 device 10 can be positioned slightly to either side of center
2 and photodetector 16 can be positioned in the opposite side of
3 the hemisphere formed by material 19. Here it will be
4 understood by those skilled in the art that in at least some
5 applications material 19 can be used to adhesively fix either
6 or both light emitting device 10 and photodetector device 16 to
7 the surface of structure 11, thus, further simplifying the
8 manufacturing or assembly process.

9

10 Thus, a new and improved power monitoring arrangement for
11 semiconductor laser devices used in optoelectronic packages is
12 disclosed. The improved power monitoring arrangement for
13 semiconductor laser devices can easily be incorporated into any
14 of the present optoelectronic packages and greatly simplifies
15 manufacturing of optoelectronic packages. By substantially
16 reducing the time and work involved in assembling a light
17 emitting device and power monitoring device, the optoelectronic
18 package can be more easily and efficiently assembled, thus,
19 substantially reducing misalignment problems and cost.

20

21 Various changes and modifications to the embodiment herein
22 chosen for purposes of illustration will readily occur to those
23 skilled in the art. To the extent that such modifications and
24 variations do not depart from the spirit of the invention, they
25 are intended to be included within the scope thereof which is
assessed only by a fair interpretation of the following claims.

1 Having fully described the invention in such clear and
2 concise terms as to enable those skilled in the art to
3 understand and practice the same, the invention claimed is: